Name of Organization: Carnegie Mellon University

Type of Organization: College or University

Contact Information: Dr. Jeanne VanBriesen

Department of Civil and Environmental Engineering

Porter Hall 119

Pittsburgh PA 15213

Phone: (412) 268 - 4603 **Extension:**

Fax: (412) 268 - 7813

E-Mail: jeanne@cmu.edu

Project Title: Bioreactive sediment capping for in situ remediation of PCBs

Project Category: Contaminated Sediments

Rank by Organization (if applicable): 0

Total Funding Requested ($): 190,000 **Project Duration:** 2 Years

Abstract:

Restoration of contaminated waterways generally involves removal of significant quantities of contaminated sediments with associated damage to the ecosystem and the requirement for ex situ chemical treatment or disposal in engineered landfill facilities. Sediment dredging is expensive, damaging to ecosystems, and although contaminant mass is removed, complete restoration of the system is very difficult to achieve. In situ engineered strategies involve installation of an impermeable barrier that isolates the sediment environment under the barrier. The barrier retards contaminant release to the environment but does not treat the contained sediments. In the proposed work, the potential for in situ treatment using a reactive barrier will be evaluated. This represents a permanent, in-place solution to the contamination as an alternative to dredging and isolation. Using batch reaction systems and flow-through microcosms, we will evaluate the impact of different chemical and biological amendments to the cap material on the natural biological removal processes for persistent organic contaminants (e.g., PCBs and PAHs). Coupled biogeochemical modeling will include evaluation of model parameter uncertainties designed to enhance the predictive capabilities and strengthen the statistical support for conclusions based on modeling simulations. Ultimately, the results would be employed in the field to guide design and installation of a thin-layer semi-permeable reactive barrier that would treat the slowly released contaminants by natural or enhanced biodegradation. Sediments from the Grasse River in St Lawrence River AOC will be used for the initial evaluation studies. Work will be linked with evaluation of existing sediment cores from this river.

Geographic Areas Affected by the Project

States:

- [x] Illinois
- [x] Indiana
- [x] Michigan
- [x] Minnesota
- [x] New York
- [x] Pennsylvania
- [x] Wisconsin
- [x] Ohio

Lakes:

- [ ] Superior
- [ ] Huron
- [ ] Michigan
- [ ] Erie
- [ ] Ontario
- [x] All Lakes

Geographic Initiatives:

- [ ] Greater Chicago
- [ ] NE Ohio
- [ ] NW Indiana
- [ ] SE Michigan
- [ ] Lake St. Clair

Primary Affected Area of Concern: All AOCs

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area:

Other Affected Biodiversity Investment Areas:

Problem Statement:

Many persistent organic contaminants (e.g., PCBs, PAHs, metals) accumulate in the sediment of rivers and lakes. These contaminants are slowly released from the sediments to the overlying river where toxicity and bioaccumulation are concerns. Sediment cleanup often involves expensive and inaccurate dredging of contaminated material for disposal in landfills. In situ capping of contaminated sediments offers an option that results in (1) physical isolation of the contaminated sediment from the benthic environment, (2) stabilization of contaminated sediments, preventing resuspension and transport to other sites, and (3) reduction of the flux of dissolved contaminants into the water column (Palermo et al, 1996). However, in situ capping does not result in reduction of the contaminants and the flux of dissolved contaminants to the water column continues over decades to centuries. In situ treatment of slowly degraded organic contaminants presents a problem due to the long time frames necessary for natural or accelerated bioremediation strategies. A reactive cap could potentially overcome the immediate problem on contaminant flux to the water and provide the biological acceleration and the increased time necessary for contaminant removal through biological attenuation processes.

Proposed Work Outcome:

The proposed work involves a series of hypothesis-driven tasks designed to increase our understanding of chemical and biological amendments that have the potential to enhance PCB and PAH transformation in an engineered sediment cap.

The following hypotheses will be addressed: (1) Anaerobic PCB degradation can be enhanced by addition of electron donor substrates, (2) Anaerobic PAH degradation can be enhanced by addition of electron acceptor substrates, and (3) Enhancement of combined PCB and PAH degradation may require multiple layers of different reactive cap materials.

The resolution of these hypotheses will be accomplished by a series of four interactive tasks. Task A is designed to quantify systematically the enhancement

to PCB or PAH degradation in the presence of different electron donor and acceptor substrates. This work will be completed in well-mixed sediment and cap systems to achieve a "best-case" rate enhancement prediction. Task B is designed to evaluate the interactions between PCB and PAH degradation in the same system. Well-mixed batch systems will again be used but additions of the most successful reactive cap materials identified in Task A will be staged to evaluate the potential of a multiple layer reactive cap for mixed contamination. Task C is designed to quantify the effects of enhancement in more representative, microcosm stream systems. These involve placing sediment in stream microcosms and capping it with different reactive material matrices. Task D will involve utilizing (and modifying if necessary) existing sediment reactive transport models to evaluate the impact of enhanced biodegradation on the overall release of PCBs and PAHs to the water.

The outcomes of the work will be identification of reactive materials that could be added to in situ capping remedial actions to accelerate natural bioremediation and reduce the ultimate mass of contaminants released to the water column. Best-case rate constants for acceleration will be developed to direct the further parameterization of sediment reactive transport models.

Project Milestones:	**Dates:**
Project Start	09/2000
Microcosms Set up	10/2000
Batch Studies Begin	11/2000
Batch Studies Completed	09/2001
Modified Capping Microcosms Set up	10/2001
Data Analysis	06/2002
Draft Report	08/2002
Project End	08/2002

☐ Project Addresses Environmental Justice

If So, Description of How:

☒ Project Addresses Education/Outreach

If So, Description of How:

A graduate student will be included in the project personnel. Work on the project will be used to create a short educational workshop designed for high school students interested in environmental issues. The workshop will be offered at the 2001 and 2002 "Expanding Your Horizons in Science and Math" and the SWE High School Day Conferences held at Carnegie Mellon University.

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	112,962	5,648
Fringe:	7,331	367
Travel:	609	30
Equipment:	0	0
Supplies:	12,180	609
Contracts:	0	0
Construction:	0	0
Other:	6,880	344
Total Direct Costs:	139,962	6,998
Indirect Costs:	50,038	2,501
Total:	190,000	9,499
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

This project will receive additional in-kind support from Alcoa, Inc. Alcoa will provide technical support, analytical services, and sediment sampling data. Estimated value of this in-kind support is $30,000.

Description of Collaboration/Community Based Support: